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RECOMMENDATIONS FOR OFF-ROAD TRANSPORTATION OF TIMBER

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RECOMMENDATIONS FOR OFF-ROAD TRANSPORTATION OF TIMBER

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Indian Standard

RECOMMENDATIONS FOR OFF-ROAD TRANSPORTATION OF TIMBER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 28 February 1985, after the draft finalized by the Timber Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 In this recommendation, the salient features of various methods of off-road transportation have been discussed giving the merits and demerits of each method and it is left to the discretion of the concerned authority to choose the method or combination of methods best suited to the particular situation. The recommendations also discuss briefly the factors to be considered in making such choice. In addition to the recommendations made in this specification, there are other socio-economic factors which influence the choice of off-road transportation which are not covered in this code.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers different methods of off-road transportation of timber employed under different conditions in the country.

1.2 The equipments required in these methods are not covered in this standard.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 707-1976† and the following shall apply.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms applicable to timber technology and utilization (*second revision*).

2.1.1 *Off-Road Transportation* — Transport of timber in the form of logs or scants from the stump site to the points of loading on trucks for on-road transportation or launching in river is termed as off-road transportation. It is also called as terrain transportation or minor transportation.

3. METHODS OF OFF-ROAD TRANSPORTATION

3.1 Methods of off-road transportation may be classified as follows:

a) *Transport of Timber Over Land*

1) Carrying manually,
2) Extraction by animals,
3) Extraction by carts,
4) Extraction by rolling,
5) Extraction by sliding,
6) Dry slide,
7) Wet slide,
8) Telescopic floating,
9) Extraction by tractor, and
10) Skidding by winches.

b) *Overhead Transportation of Timber*

1) Extraction by wire skidding,
2) Extraction by gravity ropeways,
3) Extraction by gravity skyline cranes, and
4) Extraction by non-gravity skyline cranes.

4. FACTORS DECIDING THE CHOICE OF PARTICULAR OFF-ROAD TRANSPORTATION METHOD

4.1 Factors as given in **4.1.1 to 4.1.11** should be kept in view while deciding about the choice of a particular off-road transportation system to be adopted.

4.1.1 *Terrain* — The method should suit to particular terrain condition of the forest. This condition, in most cases, is the limiting factor in deciding a particular method of off-road transportation.

4.1.2 *Road-System* — Road system in and around the forest area also influences off-road transportation methods to be adopted.

4.1.3 *Size of Timber* — The method should be suitable for the size, length and volume of the timber to be transported.

4.1.4 *Lead* — Lead which is a limiting factor for off-road transportation should also be considered when selecting the method.

4.1.5 *Volume of Timber to be Transported* — Volume of timber should commensurate with the particular off-road transportation method. For small volume, heavy investment is not economical.

4.1.6 *Value of Timber* — Valuable timber may be transported through costly methods, if necessary.

4.1.7 *Cost* — Methods involving less investment and quicker recovery of capital are preferable over those involving higher investment and/or time consuming.

4.1.8 *Time* — Due to limited working period for forest harvesting and for early returns from the investment there should be minimum time involved in operation.

4.1.9 *Labour* — Where labour is scarce and costly, the labour intensive methods are obviously not suitable.

4.1.10 *Soil Erosion and Crop Damage* — Methods causing least damage to the soil and the standing crop should be adopted.

4.1.11 *Climate* — Intensity and duration of heat, rain and snow in the operational area may also influence the off-road transportation method.

5. OFF-ROAD TRANSPORT OF TIMBER OVER LAND

5.1 Carrying Manually

5.1.1 *Description* — Timber in the form of sleepers, beams, scantlings and planks, is carried by men on their back. This method is conventionally employed in absence of roads in hilly areas. A rope encircling the shoulders of the men is tied to the load of timber resting on his back. The load can be taken up-hill or down-hill through bridle paths to the nearest road, gravity ropeway or launching site for further transportation.

5.1.2 *Merits and Demerits*

5.1.2.1 The terrain is such that no other means are available, that is, inaccessible areas where even animal transport is not available, and overhead transport is ruled out in absence of suitable equipments and that the quantity of timber is not adequate to justify new investment on equipments.

5.1.2.2 The material is normally transported in sawn form as sleepers, scantlings, etc.

5.1.2.3 The weight and length of the material is within the carrying capacity of human labour.

5.1.2.4 The human labour is cheap and easily available. The lead of transport is small which should not exceed 2 km. Higher lead will be uneconomical being a time consuming and strenuous job.

5.1.3 *Precaution*

5.1.3.1 The weight and length of the scants should be within the prescribed limits, otherwise the labour may loose balance while walking with load, particularly on narrow, slippery and sloping ground.

5.2 Extraction by Animals

5.2.1 *Description* — For the extraction of timber in log form from the felling site to the nearest road, draught animals, namely, elephants, buffaloes and bullocks are employed. Logs are fastened with chains of fibre ropes. The other ends of the chain are hooked with the dragging gear of the animal, which is different for different kinds of animals. The animal drags the logs on rough paths through skid tracks on the terrain. The end of the log is slightly rounded off (snouted) to prevent its ploughing into the ground.

5.2.2 *Merits and Demerits*

5.2.2.1 This method of transportation of timber suits the areas where lead of transport is small which should normally not exceed 500 m in hills and 1 km in plains.

5.2.2.2 The weight of the load is limited to the capacity of the draught animals.

Elephant	1 tonne
Buffalo	300 kg
Bullock	200 kg
Mule	150 kg

5.2.2.3 The bullocks or buffaloes are generally employed in pairs and on nearly flat grounds in plains for dragging of logs while elephants or mules are employed singly and can well negotiate semi-hilly terrains.

5.2.2.4 A suitable wooden sledge for efficient skidding of loads will reduce work load on animals. Proper sledge and dragging gear for animals should be provided.

5.2.2.5 For animals, carrying the load, a drag path should be provided for movements in hilly areas which should be properly maintained specially on curves for free movement of the animal with load.

5.2.2.6 There is necessity of continuous presence of personnel for the maintenance (feeding, grooming, etc) of the draught animals even on non-working days.

5.2.2.7 The investment cannot be retrieved in case of accidents and danger of loss through illness.

5.2.2.8 The daily output is quite low as the animals have low speed of walking and can work only for a limited time.

5.2.3 *Precautions*

5.2.3.1 The weight and length of timber should be such that the animal may move freely without loosing balance on slopes.

5.2.3.2 The animals should not be put into work every day of the week specially in hot weather.

5.2.3.3 The animal should be properly harnessed to drag the loads.

5.2.3.4 Intermittant rest should always be given to the animal while on work.

5.2.3.5 Animals should not be engaged for more than six hours a day, specially in hot weather.

5.2.3.6 Making drag holes on logs should be avoided to save wastage of timber. Instead, the logs should be fastened by choker ropes which would not allow the logs to slip out. Metal or fibreglass snouts are also used for such purposes.

5.3 Extraction by Carts

5.3.1 *Description* — Carts driven by bullocks or buffaloes are extensively used for carrying timber in sawn and log form in plain forests. Carts are taken right up to the stump site for loading wherever possible. Small logs which can be lifted manually are loaded from any side of the cart but for big logs the cart is laid on its side by removing one of the wheels and the log is rolled in manually after which the cart is put to upright position by lever action. The loaded carts are then driven out of forests on cart roads.

5.3.2 *Merits and Demerits*

5.3.2.1 The ground should be sufficiently flat to allow movement of the cart. In undulating areas, the average gradient should not exceed 5°.

5.3.2.2 The girth of the logs, to be transported in ordinary carts should not exceed 2 m in girth.

5.3.2.3 The length of the logs or scants should normally not exceed 3 m.

5.3.2.4 The load on the ordinary wooden two-wheeled carts can be up to 400 kg on rough grounds and about 500 kg on hard surface and on metalled road. Higher loads up to 2·5 tonnes can be carried on carts with tyre wheels with ball bearings on axles.

5.3.2.5 There should be clear track about 2·50 m wide for the movement of the cart.

5.3.2.6 Movement of the carts on forest motor roads damages the road surface and forms ruts, so a separate cart track is often provided. However, if carts are provided with pneumatic tyre wheels instead of wooden wheels, forest motor road can also be used.

5.3.2.7 The lead through this method of transport should be not more than 5 km. Being a time consuming method, longer lead may be uneconomical. Moreover, return journey is unproductive.

5.3.3 *Precautions*

5.3.3.1 The condition of the bullocks and cart should be sound enough to carry the loads.

5.3.3.2 The draught animals should be properly cared.

5.3.3.3 In muddy areas the load should be less than what is normally allowed on the cart.

5.3.3.4 The animals should be fitted with a fast harness so that the load on the cart is balanced and the pressure exerted on the neck of the bullocks is low.

5.3.3.5 Carts for timber transport need to be developed. The ordinary carts with two wooden wheels for agricultural use are not recommended for timber transport. Two or four wheeled carts with tyre or solid rubber wheels can be developed and used for timber transport.

5.3.3.6 The working with draught confined should not exceed 6 hours a day. Intermittant rest to animal is essential. Work should be suspended in mid day during summer season and should be carried out mostly in the morning hours. Animals need proper care for feed and water.

5.4 Extraction by Rolling

5.4.1 *Description* — Logs are rolled on slopes over small distances. Rolling of logs is helped by elephants or men using stout wooden poles as

levers. To facilitate rolling on easy slopes, rails area some times made by lying two parallel rows of poles, half sunk in the ground on which the logs are rolled. Only one log at a time is moved to short distance. The next log is rolled down after the first one stops. Logs are rolled one by one until a lot of 30-40 logs have been moved. The logs are further moved in stages.

5.4.2 *Merits and Demerits*

5.4.2.1 The system should be applied only in those areas where average down-hill gradient is in between 3° and 10°.

5.4.2.2 The lead should not exceed 1 km in length.

5.4.2.3 The weight of the log should not exceed one tonne.

5.4.2.4 The labour engaged should have sufficient experience of the work.

5.4.2.5 Arrangements to check the rolling speed of the logs and to stop them at about every 10 metres interval should be made so that the movement of the logs is controlled.

5.4.2.6 Proper arrangements to change the direction of the logs on rolling paths at sharp curves should be made.

5.4.2.7 Log rolling can cause damage to young regeneration and also ground surface resulting in soil erosion. Repeated rolling and sliding of logs on a hill slope will create ruts and permanent gullies.

5.4.3 *Precautions*

5.4.3.1 The logs should be rolled down one by one so that the weight and the speed of logs is always under control.

5.4.3.2 This is a risky method and accidents are common due to uncertain movement of logs down the slope and labourer and passer by can get hit while controlling the movement of logs.

5.4.3.3 Instead of putting stones only in front of the log to keep it stationary wooden wedges may also be used to have firm stoppages.

5.4.3.4 The method should be employed only when no other alternative is forthcoming as damage to the logs and ground surface is considerable. Soil erosion may be caused by repeated rolling and sliding.

5.5 Extraction by Sliding

5.5.1 *Description* — An earth slide is a natural depression or hollow, improved by artificial means such as the removal of boulders, etc, so that

timber can be slided down the hill by virtue of their own weight. Timber in log or sawn scant forms can be moved on hill slopes by sliding, specially along the depressions or hollow.

5.5.1.1 Generally the slides are straight but when natural curves or bends of short length occur, at suitable intervals, these are treated as advantage as timber cannot move at uncontrolled speed. So long as the slope does not exceed 25°, no special steps need be taken to check the velocity but where it exceeds, check walls are erected at suitable intervals in order to break the speed of sliding timber.

5.5.2 *Merits and Demerits*

5.5.2.1 This method is limited to down-hill transportation only.

5.5.2.2 This system of transport should be applied where the ground is fairly hard and compact and no rocks, stones or other obstacles are in the way.

5.5.2.3 Slope should not be less than 15° and not more than 25°.

5.5.2.4 The lead for this system should not exceed 200 metres.

5.5.2.5 There is considerable end damage to the timber, the ends are generally rounded off to reduce end splitting.

5.5.2.6 There is considerable damage to the ground which may result in soil erosion and gully formation on slopes.

5.5.3 *Precaution*

5.5.3.1 There is possibility of accident in this method so the labour engaged should be skilled enough to perform the job.

5.5.3.2 Higher gradient of slope should be avoided as this increases the sliding speed of timber due to which the timber may jump out of the slide and cause damage.

5.6 Dry Slide

5.6.1 *Description* — Where the terrain is difficult, rocky or soft for ground rolling or sliding, dry timber slides are used to slide logs down the slope diagonally. It is constructed by pitching logs end-to-end in 2-3 rows, to form a trough shaped slide, which may be straight along the slopes or across diagonally down-hill. It can be made in required length. The logs which are to be transported may be used in its construction and after all logs have been transported, the slide itself it dismantled from the upper end and the logs, thus obtained, are also slided down through the remaining

portion of the slide. When logs of different sizes are to be used in its construction the bigger logs should be placed at the sides and the smaller logs at the bottom of the trough of the log slide.

5.6.1.1 A gradient between 15° and 25° is more suitable for controlled sliding. Instead of maintaining uniform gradients along the slides the steeper portions can be followed by levelled portions, the length of such levelled portions of the slide should be such that the velocity attained by the logs through steeper portions of the slide become minimum before entering the next steeper portion. The success of the slide depends almost entirely upon the care and skill with which it has been aligned and constructed.

5.6.2 *Merits and Demerits*

5.6.2.1 This method is limited to down-hill transportation only.

5.6.2.2 The gradient of the dry timber slide should not be uniform over long lengths but should be of different gradients. A steep portion should be followed by a low gradient portion. The suitability of the gradient also depends on the size of the logs. The average gradient of the entire lead of the slide should be about 10° and the maximum gradient should not exceed 25°.

5.6.2.3 Alignment and construction of log slides should be done by skilled persons.

5.6.2.4 The lead should not be more than 200 m. The slope and ground conditions should be suitable and landing at the bottom of the log slide should be safe with enough space for storing. This need to be linked with further transportation method by road, cableways or water.

5.6.3 *Precautions*

5.6.3.1 Precautions shall be taken to prevent the logs from moving down too rapidly to prevent flying off the slide which may be dangerous and also make further movement of such logs more difficult.

5.6.3.2 In steep gradients the velocity should be lessened by throwing earth or sand on the slide.

5.6.3.3 The logs pitching should be firm and should be clamped by iron nails or clamps.

5.6.3.4 Where the surface of the ground does not allow the log to move by its own weight, arrangement should be made for providing water on to the slide. The water will make the slide more slippery and will facilitate the downward passage of the logs.

5.6.3.5 In frozen and snowy areas the gradient of slide should not be more than 20°.

5.6.3.6 Only those labour should be engaged on this work who have got sufficient practical knowledge and experiences of the work.

5.6.3.7 On depressions proper support should be provided to the slide from the bottom as well as from the sides.

5.6.3.8 The sliding should not be done immediately after heavy rain.

5.7 Wet Slide

5.7.1 *Description* — Wet timber slides are generally used for extraction of timber converted into sleepers and scants from higher to lower elevation in hill forests through water courses. The sliding of sawn timber by virtue of its own weight in the wooden trough is helped by sprinkling water to reduce friction and make sliding smooth.

5.7.1.1 Wet timber slide consists of rectangular channels constructed by placing sleepers and sawn scants end-to-end in rows. The joints are plugged with moss or by grass or leaves to make them water-tight. The trough is provided with supports of rough wooden blocks and poles throughout its length to maintain a constant down gradient. Wet slide should be in sections so that the supply of water for its entire length is ensured. Generally a pool of water is made at the head of each section of the slide to maintain the fresh supply of water. The timber pieces are guided by workers by sticks with iron hooks.

5.7.2 *Merits and Demerits*

5.7.2.1 Only sawn timber, in the form of sleepers, and scants are transported through this method. It is practicable along water courses.

5.7.2.2 The possible gradient for wet sliding varies from 5° to 25° but the optimum gradient is 15°.

5.7.2.3 On low gradients more supply of water is required while on greater gradients little water serves the purpose of helping downward movement of sleepers.

5.7.2.4 The gradient should be lower on curves and curve should be in large arcs.

5.7.2.5 There should be no sudden change in the gradient off the slide to avoid throwing out of timber from the slide.

5.7.2.6 The slide should be constructed in sections, the length of which depends to some extent on the nature of the ground traversed. The length of each section should be around 200 metres.

5.7.2.7 Each section should be so constructed that sufficient fresh water is available at the head of each section and water should reach to the end of the section. The slides should follow more or less closely to the course of a stream. In case the flow of water is not sufficient in the stream, its water is stored in pools at the head of each section of slide and while sending the sleepers through slide the water is discharged from the pool.

5.7.2.8 Considerable engineering skill is required in the alignment and construction of wet slide by timber pieces.

5.7.2.9 In rainy season there is every possibility of damage to the slide due to floods and land slides. This should be used to during summer and winters, generally, this is done soon after rainy season as in most of the water courses the flow of water will fast decrease after the rains.

5.7.2.10 The construction of slide involves considerable time and money, therefore, there should be adequate quantity of timber to be transported through it to make the work economical.

5.7.2.11 Dismantling of slide should be started from the top so that dismantled sleepers and scants could also be transported through the remaining portion of the slide.

5.7.3 *Precautions*

5.7.3.1 Alignment and construction should be done by experienced person.

5.7.3.2 There should always be sufficient water flowing in the slide; without water the friction may generate heat and cause fire.

5.7.3.3 There should not be abrupt changes in the gradient, nor there should be narrow curves.

5.7.3.4 Proper supports should be provided to the slide at depression.

5.8 Telescopic Floating

5.8.1 *Description* — Transportation of timber along bigger streams by ordinary floating of timber is often not possible due to number of big boulders, rocks and other obstacles. Therefore, timber in sawn form is moved through telescopic floating over difficult portions of the stream. In this method a wooden trough is made along the stream or water course. This water is diverted on to the wooden trough to move down the timber. The water leakage in the trough is stopped with the help of mosses from the river to maintain sufficient water flow in the trough. Timber in the form of scants and sleepers are mostly floated down the trough to reach

the lower end of the trough, small sized logs and poles can also be transported through this method.

5.8.2 *Merits and Demerits*

5.8.2.1 This method is employed on side streams of moderate gradients of about 5°.

5.8.2.2 Engineering skill is required in the installation of timber trough.

5.8.2.3 The timber trough may be made in many sections and the length of each section should not exceed half km, depending on stream course and amount of water flow.

5.8.2.4 There should be sufficient water flowing in the trough so that timber floats and moves smoothly.

5.8.2.5 To ensure water supply small dams may be made at the top end of the section. Wherever depressions are crossed by the trough, proper supports should be provided to hold the trough intact.

5.8.2.6 Only, floatable timber species can be transported by this method.

5.8.2.7 Sharp turns in the trough should be avoided.

5.8.2.8 A continuous long stretch of regular slope in the trough increases the velocity of the scants in the trough. To check the speed of sleepers the gradient is manipulated and maintained correctly.

5.8.2.9 There should be sufficient material to transport through this method as much labour cost is involved in the installation of the trough. This method can be better used soon after rains when the streams have good flow of water.

5.8.2.10 In rainy season the timber trough is liable to get damaged by the flood or land slides.

5.8.2.11 *Sudden* — Sudden rains and flood in hill streams can wash away the timber and cause losses.

5.8.3 *Precautions*

5.8.3.1 A pool at the end of each section should be made to avoid damage of the timber by striking with boulders.

5.8.3.2 The stream banks, where making of trough is not necessary, should be lined with scantlings to ensure smooth floating of timber.

5.8.3.3 Heavy rains and floods can cause damage to the installation hence frequent checking and maintenance of channels is necessary.

5.9 Extraction by Tractor

5.9.1 *Description* — The ordinary farm tractor can be used for terrain transport of logs. The log skidding attachments like calliper grab, T-bars, etc, are fitted to the rear of the tractor hydraulic arms. The ends of the logs are grappled by the forked hooks of the calliper grab and is lifted by hydraulic levers. The tractor is moved and the logs are skidded to landing one by one. In T-bar, the logs are tied with chains at one end and the chains are then hooked on to the slots of the bar. Up to 6 logs can be skidded on one trip, depending upon sizes and ground conditions.

5.9.1.1 Where the ground conditions do not favour the movement of wheel tractors due to poor soil bearing capacity or snow, crawler tractors can be used. The crawler tractors are specially provided with having drum capacity up to 200 metres cable, 12 mm diameter and also a fair lead roller attachment for skidding the logs to make full load and then carry sufficient load of number of logs to landings. Individual logs are attached with choker ropes on to the main hauling cable of the tractor winch passing through the fair lead. The ends of the logs remain lifted from the ground to avoid their ploughing on the ground or striking against small boulders and other ground obstructions.

5.9.2 *Merits and Demerits*

5.9.2.1 The farm tractor can be employed normally in plain or semi-plain areas where the gradient does not exceed 10°. In mountain areas the tractors are specially designed for negotiating high altitudes and cold climate There are forestry tractors, wheeled type and crawlers.

5.9.2.2 The ground soil should have sufficient bearing capacity to avoid sinking of the tractor wheels and tracks.

5.9.2.3 Tractor driving and skidding loads on very irregular grounds with too many boulders, pits and stumps is difficult; skidding tracks are to be prepared.

5.9.2.4 Where the ground is such that the tyres of the tractor sink or slip or get abraded, the tyre should be covered with tracks or wheel chains.

5.9.2.5 The size and weight of the logs should be decided as per the horse power of tractor to be used.

5.9.2.6 Full tree length skidding on the ground should be avoided to reduce ground resistance and obstacle. The front end of the logs is slightly raised by hydraulic lift or fair lead attachment.

5.9.2.7 The average lead of ground skidding in this system should not exceed 2 km, optimum being 1 km.

5.9.2.8 On steeper slopes where there is possibility of soil erosion due to tractor skidding, other means such as cable ways should be employed.

5.9.3 *Precautions*

5.9.3.1 Tractor should never be tried where:

a) the logs are too big and beyond its capacity,

b) the soil has low and poor bearing capacity, and

c) the gradients are too steep.

5.9.3.2 Tractor operator should be well experienced with the tractor and log skidding.

5.9.3.3 Workshop facility for the maintenance of the tractor with necessary spares should be readily available.

5.10 Skidding by Winches

5.10.1 *Description* — Portable powered winches, driven by petrol or diesel engine and fitted with a cable drum are used to extract logs from undulating and hilly terrains. Extraction of log is difficult in such areas where the terrain is very steep and ground is cut up by ramification of **nallahas.**

5.10.1.1 The winch mounted on skids is anchored to a tree or a rock near roadside. The free end of the cable from its drum is taken manually to the logs, and tied to one end of the log or the end which has special kind of hooks, cabled sphereloid hook or other kinds is attached to choker ropes with which the logs are tied at the ends. The winch then drags it as the drum revolves winding the cable. To avoid obstacle on the way, the pulling direction can be deviated by providing snatch block through which the handling cable passes. Tractors fitted with winches are also suitable depending upon terrain and road conditions to use which combined with tractor skidding.

5.10.2 *Merits and Demerits*

5.10.2.1 The area, not fit for tractors operations due to steep and irregular terrain, clifts and sharp valleys, etc, can be worked through winches.

5.10.2.2 Normally, the lead for winch skidding should not exceed 200 m.

5.10.2.3 The ground surface should be fairly hard to facilitate surface dragging.

5.10.2.4 The winch should be portable, mounted on skids or should be attached to tractor for mobility.

5.10.2.5 The capacity of engine and the winch should be decided considering the weight of the logs to be dragged, and the condition of the ground surface.

5.10.2.6 High stumps and boulders jetting out of the ground are a limitation.

5.10.3 *Precautions*

5.10.3.1 The winch should be properly anchored by the steel wire ropes. No weight beyond the allowed capacity of the winch should be dragged.

5.10.3.2 The log should be firmly tied to the winch rope with the help of a choker rope and hooks. Use of worn out cables should be avoided for safety.

5.10.3.3 The log should be dragged with more or less uniform engine speed. There should not be abrupt changes in speed, which may damage the winch and the cable, and may cause accidents.

5.10.3.4 The movement of logs should always be under watch to avoid striking of logs against stumps or rocks en-route.

5.10.3.5 The handling of the winch should be by a trained operator who should know about the maintenance and minor repair of the winch to avoid unnecessary delays in working.

6. OVERHEAD TRANSPORTATION OF TIMBER

6.1 Extraction by Wire Skidding

6.1.1 *Description* — Small sized wood, namely, pulp wood and firewood can be transported down the slopes by the traction of gravity over a single strand steel wire of 4 to 5 mm diameter stretched clearly off the ground between the top (loading) station and the bottom (unloading) station.

6.1.1.1 At bottom station the wire is passed through one or two old tyres and taken round a tree for providing a good anchor. At top station, the other end of the wire is attached to a tension device through which wire is given tension (normally about 800 kg) and then it is anchored to a tree. The wood is tied into bundles by sling wires such that a loop is also formed for attaching the load to the wooden carriers, through a slotted

hole of the wooden carrier. The load with the carrier is placed on the stretched wire through the slotted hole and is allowed to skid along with the wire under the force of gravity. As soon as the carrier with the load reaches the bottom station it strikes against the tyres and is thrown away from the steel wire resulting in an automatic unloading of the bundle of wood. The wood carrier and sling wires sent down with the load, are collected and brought back to the top station to send more load.

6.1.2 *Merits and Demerits*

6.1.2 This method is limited to down-hill transportation only.

6.1.2.2 The method is suitable for pulp wood or fuel wood when breaking will not matter.

6.1.2.3 The method can be used on hill slopes of 25° to 65°.

6.1.2.4 The optimum weight of each load is about 100 kg. The best suited span is 300 metres. Intermediate supports can be provided if the slope length is more.

6.1.2.5 There should be sufficient number of wooden carriers at the top station. The empty carriers are to be carried to the top station manually. A suitable device can be provided to pull the carrier by string on the main wire.

6.1.2.6 The tension in the wire should not exceed one tonne.

6.1.3 *Precautions*

6.1.3.1 The gradient of the stretched wire should not be less as it may cause the stoppage of the load before it reaches the bottom station.

6.1.3.2 On steep gradients the load moves with a greater velocity and it may fly off the wire before reaching at the lower station, it may strike against very hard surface to cause damage. The slope has to be appropriate.

6.1.3.3 While stretching the wire, there should be no kink, the presence of which may break the wire while tensioning and the kink (knots) or bends provide obstruction to moving carriers.

6.1.3.4 The winding of the wire should be done carefully.

6.1.3.5 The tension on wire should not exceed the limit, as snapping wire under tension can cause serious accident.

6.1.3.6 The carriers moving at high velocity over long spans can catch fire due to friction on wire. The span length and velocity has to be maintained properly.

6.1.3.7 Both ends of the wire should be anchored firmly.

6.2 Gravity Ropeways

6.2.1 *Description* — Timber in the form of sleepers can be transported through aerial ropeways, under the force of gravity, down the slope in hilly areas. The system consists of one, two or three fixed wire ropes called track ropes set parallel to one another at about 90 cm to 180 cm apart and anchored at the top and bottom stations. The steel wire ropes used for track rope have diameter from 8 to 14 mm depending upon load to be passed. An endless control rope which is lighter and more flexible than track rope runs just below the central track rope and in vertical plane on round wheels installed at both the stations.

6.2.1.1 The diameter of control cable can be 6 to 8 mm. The load of timber in the form of sleepers is suspended crosswise from the track ropes by carriers which consist of pulleys and an attachment to which wire slings are fastened and the load can be hooked. Another wire sling is attached at the centre of the load and is fastened to an 'eye-let' provided in the endless control rope. When the load descends it pulls up the empty carriers which are suspended in another 'eye-let' at the bottom station. A simple but effective lever operated hand brake is used on the wheel rims to check the speed of the load before it reaches the down station. In the traditional Donald's gravity ropeway, the tension to track ropes is applied by wooden drum on which the ends of the ropes are wound manually.

6.2.2 *Merits and Demerits*

6.2.2.1 The system is applicable only in hilly terrain for down-hill transportation.

6.2.2.2 The best single spans for speed and economy are 750 to 1 050 metres. The system can be employed between a slope of 17° and 45° but the best gradient is 22° to 35°.

6.2.2.3 The weight of load to be transported should not exceed 225 kg.

6.2.2.4 Only timbers in sawn form, namely, scantlings or sleepers are transported as the load is equally distributed on the track ropes and that each timber piece can be lifted and handled manually.

6.2.2.5 At both the terminals a platform made by sleepers is necessary for suspending and collecting the timber which also provides anchorage to the ropes and wheels.

6.2.2.6 The timber has to be collected at the top station and loading and unloading of loads has to be done at each span.

6.2.2.7 The long track and control cables are to be carried on uphill manually which is hard and dangerous job.

6.2.3 *Precautions*

6.2.3.1 Before installing the equipment the location of the top and bottom station should be properly surveyed so that no obstacles come on way when load moves down and the load always remains suspended in the air while moving on track ropes.

6.2.3.2 The track ropes should be properly aligned and equally tensioned so that all the ropes are in the same plane and share the load equally.

6.2.3.3 The endless control cable should be about 1·8 m below the middle track rope.

6.2.3.4 Proper anchorages should be provided to the track ropes and the wheels at both terminals.

6.2.3.5 The two ends of the control cable should be spliced properly to make it a firm endless cable.

6.2.3.6 The ropes and carrier bearings should be kept well-oiled to increase its working life.

6.2.3.7 Utmost care should be taken at points where the ropeway is crossing the roads or area frequented by people, as falling load can cause serious accidents.

6.3 Gravity Skyline Cranes

6.3.1 *Description* — Powered ropeways are commonly known as skyline cranes, which can transport timber uphill and down-hill. In this system the power is derived from a yarder fitted with an Internal Combustion Engine and a cable drum or a tractor winch. This yarder can be taken up to the top station by its own power and is placed in stationary position at the top station and is firmly anchored. A suitable track rope is anchored between top station and bottom station on which a carriage runs. The movememt of this carriage is controlled by a control cable, one end of which is fixed with a hook at the carriage and the other end to the winch drum of the yarder.

6.3.1.1 The carriage is provided with mechanized or hydraulic stop device. The carriage runs down by traction of gravity and is stopped by the control cable on the track rope at the place from where the timber is to be lifted. The carriage locks itself on the track rope. The release of control cable allows the hook from the carriage to go down beneath the skyline up to the ground from where the hook is carried to the load and fixed. The load is laterally dragged by the yarder and as soon as the load

comes beneath the skyline it is lifted up to the carriage on the track rope. As the hook strikes with the carriage, the carriage is unlocked from the track rope and the hook is locked on the carriage which can now be released down-hill or uphill with the power of the yarder. At the unloading station the carriage is again locked and the hook with the load is unlocked and goes down to the ground by releasing the control cable. The load is unhooked. Again the carriage is sent to the loading place for bringing another load. Short distance, medium and long distance skyline cranes can be used up to 2 000 m lengths with number of intermediate supports. The track ropes are 16-24 mm diameter in single length and hauling rope is 8 to 14 mm diameter. For smooth and quick operation the operator on the yarder remains in contact with the persons on loading station and unloading station through a powerful telephone system provided with loudspeakers.

6.3.2 *Merits and Demerits*

6.3.2.1 The method requires minimum gradient of 20 percent for down hill movement of empty carriage. It can work up to 100 percent gradient but the most suitable gradient is between 50 and 60 percent.

6.3.2.2 The skyline crane should be installed in places where it can be used to its full capacity, extracting enough timber in one installation. The length of the span should not normally exceed 1 600 m.

6.3.2.3 The unloading stations should be selected so as to provide space to store the timber coming through the crane and arrange for loading for further transportation.

6.3.2.4 The unloading station should also be near the roadside or river launching site for further transportation.

6.3.2.5 For easy hauling of logs and rolling down to bring the loads below the skyline, the ropeway should preferably pass over the depressions, where logs can be collected by rolling from side slopes.

6.3.2.6 Timber in log and sawn form can be transported through this system.

6.3.2.7 The average area covered by a skyline crane is 1 600 m in length and 60 m in width (30 m on either side).

6.3.2.8 After completing the working at one installation the new line can be selected keeping either the loading station or unloading station as fixed at the same place and shifting the other end of the line to another suitable place, and the lines are in radial formation to cover the whole forests on a hill slope.

6.3.2.9 The skyline cranes are best suited for clear felling areas but can be used economically in selective felling areas where timber can be brought below the skyline by other methods.

6.3.2.10 It suits steep and rough mountain terrain where cost of road construction can be prohibitive and no other system would generally be available for hauling the timber.

6.3.2.11 Handling of cable cranes requires trained and skilled operators crew. Generally a crew of six persons is required for operations.

6.3.2.12 It prevents damage to the site when the site is required to be protected.

6.3.3 *Precautions*

6.3.3.1 During tightening or slackening of cables, no one should stay in the vicinity of pulley blocks, tensioning cables and anchors. Snapping cables can cause serious accidents.

6.3.3.2 The winch should never be placed under the track rope.

6.3.3.3 The track rope should be anchored and fastened firmly and reliably at both ends.

6.3.3.4 After the installation of skyline cable, the operation should be started with light loads and should be increased gradually to its full yarding capacity.

6.3.3.5 No one should stay below the operating cable while working.

6.3.3.6 The skyline crane should not cross railway or high voltage power lines.

6.3.3.7 There should be sufficient clearance below the track rope so that the load while moving may not strike any obstacles. Intermediate supports should be provided where sufficient clearance is not available.

6.3.3.8 The weight of the load should be within the permissible capacity of the yarder and the breaking strength of the cables used.

6.3.3.9 The effect of high altitude on the power of the engine should also be kept in view for deciding the hauling capacity of the yarder.

6.4 Non-Gravity Skyline Cranes

6.4.1 *Description* — Non-gravity skyline cranes and ropeways can be used for transportation of timber both over even and undulating terrains.

Here the ropeway operation is kept independent of gravity. The main hauling cable can be an endless rope run on either direction by revolving wheels of the winch or both ends of the main hauling cable are attached to the carriage. Thus the forward and backward movements of the carriage on the track rope is controlled by the hauling cable by driving the winch on either direction. Force of gravity is not necessary for movement of the carriage in any direction. The forward and backward movements can also be controlled by double drum system. The yarder can be located, anywhere along the skyline at loading station or unloading station which may be near to the road.

6.4.1.1 In all terrain system the winch is provided with a grooved drum on winch the endless hauling cable pass through to control forward and backward movements of the carriage on the track rope. On the main cylinder drum there is a third cable controlled by the winch for lateral yarding and lifting the load up to the carriage on to the skyline cable.

6.4.1.2 There are also mono-cable systems which can be used for terrain transportation of timber. The load hooks are attached and are suspended on the moving cable at regular intervals to take loads. The moving cable, which is endless, passes through specially designed supports fixed on trees. This system can traverse areas to haul the logs up to landings.

6.4.2 *Merits and Demerits*

6.4.2.1 The quantity of timber to be hauled has to be large for economic extraction for higher investment on yarder, carriage, steel wire ropes and other accessories.

6.4.2.2 Some of those equipments and accessories are not easily available indigenously and need import.

6.4.2.3 It needs highly skilled and trained operators and crew to work for high efficiency and better returns.

6.4.3 *Precautions*

6.4.3.1 It needs very high degree of precautions for safety to work on cableways and cable cranes for terrain transportation of logs and timber.

6.4.3.2 Mountain drive of yarder should be done with highest care by skilled operators. At each time firm anchors should be used, the rope should be not less than 16 mm diameter for yarder drive.

6.4.3.3 The intermediate supports should be erected for full load and should be sturdy based on calculation of loads and stresses coming on them.

6.4.3.4 The alignment of the track rope should be perfect.

6.4.3.5 All ropes should be in good condition to eliminate all chances of snapping under stress and load.

6.4.3.6 Wire hand gloves should be used by the crew members while handling ropes and chokers.

6.4.3.7 Every one should be made fully aware of hazards near the moving cables.

(*Continued from page* 2)

Members	*Representing*
CHIEF CONSERVATOR OF FORESTS	Forest Department, Government of Himachal Pradesh, Simla
CONSERVATOR OF FORESTS (*Alternate*)	
CHIEF CONSERVATOR OF FORESTS	Forest Department, Government of West Bengal, Calcutta
CONSERVATOR OF FORESTS (*Alternate*)	
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SHRI P. C. SHARMA	Directorate General of Civil Aviation, New Delhi
SHRI R. T. SOMAIYA	Bombay Timber Merchants Association Limited, Bombay
SHRI JIMMY WADIA (*Alternate*)	

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2